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original article

Computed Tomography Technicians and Radiographers' Competency toward different CT Exposure parameters: A cross-sectional Study

Kompetence radiologických asistentů v oblasti volby expozičnch parametrů CT: průřezová studie

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Major statement
Computed Tomography (CT) imaging has become a vital component to enhance medical diagnosis. To ensure the safety and effectiveness of CT imaging procedures, radiographers and CT technicians must be proficient in controlling CT exposure settings.

Hlavní stanovisko práce
Výpočetní tomografie (CT) se stala nezbytnou součástí zlepšování lékařské diagnostiky. Aby byla zajištěna bezpečnost a účinnost CT vyšetření, musí radiologičtí asistenti ovládat nastavení expozice CT.

SUMMARY

Abuanzeh HE, Al-Qaaneh AM. Computed Tomography Technicians and Radiographers' Competency toward different CT Exposure parameters: A cross-sectional Study

Objective: To assess the level of knowledge of radiographers and CT technicians regarding examination dose, image quality, and the ability to balance between these parameters and their associated factors.

Methods: A descriptive cross-sectional study was conducted among CT radiographers and technicians in Jordan from May to June 2024 using a validated, structured online questionnaire. The tool included both self--assessment and objectively scored knowledge sections. Knowledge scores were compared across demographic and professional variables using non-parametric tests.

Results: A total of 197 participants were included in the analysis. More than half were CT technicians, and the majority worked in private hospitals or centers (53.3%). Approximately 50% held a bachelor's degree in radiography, and 82.2% had attended specialized training after graduation. Participants with a master's degree, 11–20 years of experience, and those aged 41–50 years demonstrated significantly higher objective knowledge scores, particularly

SOUHRN

Abuanzeh HE, Al-Qaaneh AM. Kompetence radiologických asistentů v oblasti volby expozičnch parametrů CT: průřezová studie

Cíl: Posoudit úroveň znalostí radiologů a techniků CT ohledně dávky záření, kvality obrazu a schopnosti vyvážit tyto parametry a související faktory.

Metodika: V období od května do června 2024 byla mezi radiologickými asistenty pracujícími na CT v Jordánsku provedena deskriptivní průřezová studie s využitím validovaného strukturovaného online dotazníku. Tento dotazník zahrnoval jak sebehodnocení, tak objektivně bodované části týkající se znalostí. Skóre znalostí bylo porovnáno s demografickými a profesními proměnnými pomocí neparametrických testů.

Výsledky: Do analýzy bylo zahrnuto celkem 197 účastníků. Většina pracovala v soukromých nemocnicích nebo centrech (53,3 %). Přibližně 50 % mělo bakalářský titul v oboru radiografie a 82,2 % absolvovalo po ukončení studia specializované školení. Účastníci s magisterským titulem, 11–20 lety praxe a ve věku 41–50 let dosáhli výrazně vyšších objektivních výsledků v oblasti znalostí, zejména v oblasti kvality obrazu a celkových znalostí. Účast in image quality and total knowledge domains. Attendance at specialized courses was also significantly associated with better performance.

Conclusion: Radiographers and CT technologists in Jordan demonstrated good knowledge of CT exposure parameters, with higher education, experience, and specialized training linked to better performance. While overall knowledge was satisfactory, targeted improvements are needed to bridge specific knowledge gaps and promote consistent excellence in clinical CT practice. Structured training and regular competency assessments are recommended to enhance practice and patient safety.

Key words: computed tomography, radiation dose, image quality, knowledge.

na specializovaných kurzech byla také významně spojena s lepšími výsledky.

Závěr: Radiologičtí asistenti v Jordánsku prokázali dobré znalosti parametrů expozice CT, přičemž vyšší vzdělání, praxe a specializované školení souvisely s lepšími výsledky. Ačkoliv celkové znalosti byly uspokojivé, jsou potřeba cílená zlepšení, aby se překlenuly konkrétní mezery ve znalostech a podpořila se konzistentní excelence v klinické praxi CT. Pro zlepšení praxe a bezpečnosti pacientů se doporučuje strukturované školení a pravidelné hodnocení kompetencí.

Klíčová slova: výpočetní tomografie, radiační dávka, kvalita zobrazení, znalosti.

INTRODUCTION

Computed Tomography (CT) imaging has emerged as a cornerstone in modern medical diagnostics, offering unparalleled insights into the human anatomy and pathology through detailed cross-sectional imaging. This imaging modality utilizes X-rays to generate high-resolution images of the human body, making it indispensable for diagnosing a wide array of medical conditions ranging from trauma to cancer (1). Modern CT systems incorporate advanced technologies such as multi-slice acquisition, iterative image reconstruction, dual-energy imaging, and automatic exposure control. These innovations have significantly improved diagnostic performance but also require greater precision in parameter selection to ensure optimal image quality with minimal radiation exposure (2, 3). These parameters include but are not limited to tube current, tube voltage and scan time (4, 5).

In Jordan, CT services are delivered across governmental, military, and private healthcare sectors, and are typically operated by both radiographers and CT technicians. A radiologist is a medical doctor (MD) who holds a bachelor's degree in medicine and has completed specialized training in radiologic imaging. Radiologists are primarily responsible for interpreting diagnostic images and guiding clinical decisions. In contrast, a CT technician (computed tomography technologist) is a medical imaging specialist who typically holds a diploma, bachelor's, or master's degree in radiological sciences. Their responsibilities include preparing patients, operating CT scanners, adjusting exposure parameters, and ensuring adherence to radiation safety protocols. While CT technicians manage the imaging process, they work under the guidance of radiologists who interpret the results. While prior studies in Jordan have evaluated general knowledge of CT parameters or radiation safety principles, none have comprehensively assessed both self-perceived and objectively measured competence in balancing image quality with minimizing patient dose, nor examined how education, experience, and specialized training collectively influence this competence across all healthcare sectors.

The proficiency of radiographers and CT technicians in managing CT exposure parameters is paramount for ensuring the safety and efficacy of CT imaging procedures. Furthermore, radiographers and CT technicians are tasked with setting and adjusting these parameters to achieve diagnostic-quality images while minimizing radiation exposure to patients following the ALARA (As Low As Reasonably Achievable) principle (6, 7). On the other hand, inadequate knowledge or improper application of exposure parameters can compromise imaging quality, diagnostic accuracy, and potentially lead to missed diagnoses or incorrect treatments, and increase the radiation dose received by patients, which raises concerns about radiation-related health risks (8, 9).

Accordingly, and given the rapid evolution of CT imaging technology and the increasing complexity of diagnostic procedures, there is a growing need to assess the knowledge of radiographers and CT technicians in managing CT exposure parameters related to the examination dose, image quality, and the adequate skills to make the balance between these two pieces of knowledge. Furthermore, the factors that are associated with the knowledge and competences of radiographers and CT technicians in adhering to different radiation safety principles and exposure optimization techniques (CT exposure standards) remain a subject of inquiry and have to be identified (10, 11).

In Jordan, there is a substantial gap in our understanding of the knowledge and awareness levels of different CT exposure standards (12). This gap poses significant challenges to the quality and safety of CT imaging services in Jordanian healthcare facilities (13). Therefore, this study was conducted to assess the knowledge of radiographers and CT technicians in managing CT exposure parameters related to the examination dose, image quality, and ability to balance between these two parameters and to identify the factors that may be associated with this knowledge in different healthcare settings in Jordan.

METHODS

Study Design and Approval

A descriptive cross-sectional study was conducted through an online questionnaire to assess the knowledge of radiographers and CT technicians in managing CT exposure parameters related to patient dose, image quality, and their ability to balance between these two parameters their associated factors in Jordan. Questionnaire data were collected from May 15 to June 30/2024 using the online platform „Google Forms“. A unique email address was only allowed to participate once to ensure that each participant was real. Social media platforms were used to conduct a digital campaign targeting a convenience sample of radiographers and CT technicians from Jordan. Although convenience sampling may introduce selection bias, we aimed to reduce this risk by promoting the survey across diverse institutions (government, private, and military). Data was collected anonymously, and no personal identifiable information was collected or stored. Consent to participate was obtained for each participant before answering the questions of the survey questions. All questions were written and validated in the English language. This study was approved by the institutional review board (IRB) at Al-Balqa Applied University/ Al-Salt (Approval No. 26/3/1/814).

Study Tool

To measure the knowledge of radiographers and CT technicians in managing CT exposure parameters and the ability to balance between these parameters and their associated factors, the questionnaire was designed by a panel of radiography experts from both academic and clinical backgrounds, each with over ten years of professional experience. The tool underwent face and content validation, and the expert panel reviewed it for relevance, clarity, and comprehensiveness. A pilot test was conducted among 20 radiographers to assess reliability and clarity, resulting in a Cronbach's alpha of 0.80. The tool consists of seven sections: **Section I:** Demographic information (10 items). **Sections II:** Perception of academic degrees, certificates, and training programs impact on knowledge of different exposure parameters (5 items). **Section III:** Self-assessment of knowledge on patient dose (2 items). **Section IV:** Objective knowledge of patient dose (7 items). **Section V:** Objective knowledge of image quality and noise (13 items). **Section VI:** Self-assessment of knowledge on dose–image quality balance (3 items). **Section VII:** Objective knowledge of balancing dose and image quality (3 items).

For the objectively scored sections (IV, V, and VII), each correct answer received 1 point, and each incorrect answer received 0. These scores were summed to generate domain-specific and total knowledge scores (attachment 1).

Data collection and analysis

Data was extracted on a Microsoft Excel sheet. The categorical variables are presented as frequencies and percentages. Continuous variables are presented as Median and Interquartile range (IQR). Differences in the numbers of radiographers and CT technicians in relation to (i) different demographics, (ii) the perception of the radiographers and CT technicians about the Effect of academic degree, certificate, and training programs on the knowledge of different exposure parameters, (iii) how radiographers and CT technicians assess their knowledge regarding patient dose, and (iv) how radiographers and CT technicians assess their knowledge regarding the balance between patient dose and image quality were assessed by chi-square goodness-of-fit test. In contrast, the differences in radiographers and CT technicians' knowledge about the dose parameters, quality parameters, balance parameters, and total knowledge were assessed using the Kruskal-Wallis test or Mann-Whitney U test as appropriate. A post hoc test using a Bonferroni corrected p-value was utilized to determine the exact pair responsible for the significance as appropriate. All conducted tests were two-tailed and considered significant when the p-value < 0.05. No imputations were made for missing data points. All data used in the study were analyzed using SPSS 25.0 (IBM SPSS Statistics for Windows, Version 25.0, IBM Corp., Armonk, NY, USA).

RESULTS

The aim of the current research is to assess the level of knowledge of radiographers and CT technicians regarding patient dose, image quality, and the ability to balance between these parameters and their associated factors.

Demographics

Out of 200 patients who filled out the electronic questionnaire, 197 participants were included in the analysis. Three participants were excluded due to irrelevant data (e.g., mismatch between participant age and years of experience). More than 50% of participants were technicians (n=104), and the majority of participants were working for private hospitals/ centers (53.3%, n=105). Almost half of the participants had a bachelor's degree in radiography, followed by a diploma, and then a master's (49.7, 32.5, and 17.8%, respectively). It's worth mentioning that the majority of participants (82.2%)

Table 1. **Demographical data of the participants (n = 197)**
Tab. 1. **Demografická data účastníků (n = 197)**

Parameter		n (%)	χ2 (df, N)	P-value
Work sector	Governmental (n, %)	50 (25.4%)	χ2 (2, 197) = 53.83	< 0.001[a]
	Private hospitals & centers (n, %)	105 (53.3%)		
	Military (n, %)	42 (21.3%)		
Gender	Male (n, %)	90 (45.7%)	χ2 (1, 197) = 1.47	0.226[a]
	Female (n, %)	107 (54.3%)		
Level of radiology education	Diploma (n, %)	64 (32.5%)	χ2 (2, 197) = 30.28	< 0.001[a]
	Bachelor (n, %)	98 (49.7%)		
	Master (n, %)	35 (17.8%)		
Job	Technologists (n, %)	104 (52.8%)	χ2 (1, 197) = 0.61	0.433[a]
	Radiographers (n, %)	93 (47.2%)		
Age	Less than 21 (n, %)	11 (5.6%)	χ2 (5, 197) = 159.25	< 0.001[a]
	21–30 (n, %)	83 (42.1%)		
	31–40 (n, %)	53 (26.9%)		
	41–50 (n, %)	43 (21.8%)		
	51–60 (n, %)	5 (2.5%)		
	More than 61 (n, %)	2 (1.0%)		
Years of experience	Less than 5 ys (n, %)	54 (27.4%)	χ2 (5, 197) = 104.49	< 0.001[a]
	6–10 ys (n, %)	70 (35.5%)		
	11–15 ys (n, %)	36 (18.3%)		
	16–20 ys (n, %)	27 (13.7%)		
	21–25 ys (n, %)	3 (1.5%)		
	More than 25 ys (n, %)	7 (3.6%)		
Did you attend any specialized CT training course after graduation	Yes (n, %)	162 (82.2%)	χ2 (1, 197) = 81.87	< 0.001[a]
	No (n, %)	35 (17.8%)		
Are you keep update to the new training courses about CT exposure and dose optimization	Yes (n, %)	167 (84.8%)	χ2 (1, 197) = 95.27	< 0.001[a]
	No (n, %)	30 (15.2%)		
Who is responsible to decide the routine CT scan protocols in your department	Application specialist (n, %)	86 (43.7%)	χ2 (3, 197) = 80.54	< 0.001[a]
	Physicist (n, %)	11 (5.6%)		
	Technologists (n, %)	74 (37.6%)		
	Radiographers (n, %)	26 (13.2%)		
When was the last time you changed any CT protocols	One month to 1 year (n, %)	91 (46.2%)	χ2 (2, 197) = 22.46	< 0.001[a]
	1 to 2 years (n, %)	69 (35.0%)		
	More than 2 years (n, %)	37 (18.8%)		

[a]chi-square goodness-of-fit test

reported attending specialized courses after graduation. Detailed demographics are presented in Table 1.

Participants' perception of the effect of academic degree on the level of competency

Although participants reported that academic degree significantly affects the understanding of CT exposure parameters (p < 0.001), they also believe that practical experience and on-the-job-training have no effect on these understandings (p = 0.226). Detailed participants' perception about the effect of the academic degree on the understanding of different exposure parameters are presented in Table 2.

Participants' perception of their knowledge of patients' dose and balance

The majority of participants demonstrated a significant understanding of the relationship between exposure parameters and patient dose, especially when considering patient characteristics (p < 0.001) (Table 3). They also acknowledged their comprehension of the balance required between patient dose and image quality according to the ALARA principle. However, only 14.7% (n = 29) of them rated their understanding as excellent Table 4.

Level (Score) of competency among different parameters

A statistically significant difference was identified between radiographers and CT technicians in their knowledge scores related to patient dose, image quality, and overall knowledge. However, no significant difference was found between the two groups regarding their understanding of the balance between dose and image quality (p = 0.858) (Table 5). This finding aligns with the trend observed among participants with higher educational attainment, who demonstrated greater knowledge in balancing these factors. Participants with different educational levels showed statistically significant differences in their knowledge of image quality (p = 0.010) and total knowledge (p = 0.017).

The analysis based on professional experience revealed significant differences in knowledge related to patient dose, dose balancing, and overall knowledge. The disparity was most marked in image quality knowledge,

Table 2. **Participants' perception of the effect of academic degrees, certificates, and training programs on their competency on exposure parameters (Q25-29) (n = 197)**

Tab. 2. **Vnímání účastníků ohledně vlivu akademických titulů, certifikátů a vzdělávacích programů na jejich kompetence v oblasti expozičních parametrů (Q25-29) (n = 197)**

Parameter		n (%)	χ2 (df, N)	P-value
Perceptions related to academic degrees				
Do you believe that academic degree significantly influences your understanding of CT exposure parameters	Yes (n, %)	164 (83.2%)	χ2 (1, 197) = 87.11	< 0.001
	No (n, %)	33 (16.8%)		
How important do you think academic qualifications are in determining proficiency in adjusting exposure parameters for CT scans	Strongly Agree (n, %)	48 (24.4%)	χ2 (4, 197) = 112.72	< 0.001
	Agree (n, %)	88 (44.7%)		
	Neutral (n, %)	45 (22.8%)		
	Disagree (n, %)	9 (4.6%)		
	Strongly Disagree (n, %)	7 (3.6%)		
Have you observed any differences in the knowledge and skills related to exposure parameters between colleagues with different academic degrees	Yes (n, %)	170 (86.3%)	χ2 (1, 197) = 103.80	< 0.001
	No (n, %)	27 (13.7%)		
Perceptions related to postgraduate training				
Do you think that practical experience and on-the-job training have a greater impact on your ability to optimize exposure parameters than academic qualifications	Yes (n, %)	107 (54.3%)	χ2 (1, 197) = 1.47	0.226
	No (n, %)	90 (45.7%)		
In your opinion, should there be additional certification or training requirements related to exposure parameters for radiographers and CT technologists beyond academic qualifications	Yes (n, %)	179 (90.9%)	χ2 (1, 197) = 131.58	< 0.001
	No (n, %)	18 (9.1%)		

Table 3. **Participants' perception about the level of their knowledge regarding the dose parameters (Q21-22) (n = 197)**

Tab. 3. **Vnímání účastníků ohledně úrovně jejich znalostí týkajících se parametrů dávky (Q21-22) (n = 197)**

Parameter		n (%)	χ2 (df, N)	P-value
Do you feel confident in your understanding of CT exposure parameters, such as mA, kVp, and scan time	Yes (n, %)	175 (88.8%)	χ2 (1, 197) = 118.83	< 0.001
	No (n, %)	22 (11.2%)		
Do you review and adjust exposure parameters based on patient characteristics and examination requirements	Yes (n, %)	164 (83.2%)	χ2 (1, 197) = 87.11	< 0.001
	No (n, %)	33 (16.8%)		

mA – milliampere (tube current), kVp – kilovolt peak (tube voltage)

Table 4. **Participants' perception about the level of their knowledge regarding the dose/quality balance (Q20, 23-24) (n = 197)**

Tab. 4. **Vnímání účastníků ohledně úrovně jejich znalostí týkajících se rovnováhy mezi dávkou a kvalitou (Q20, 23-24) (n = 197)**

Parameter		n (%)	χ2 (df, N)	P-value
How you rate your confidence to change the CT protocol parameter correctly, by taking in your account the patient dose and image quality? (1 excellent, 5 poor)	1 (n, %)	29 (14.7%)	χ2 (4, 197) = 62.16	< 0.001
	2 (n, %)	53 (26.9%)		
	3 (n, %)	76 (38.6%)		
	4 (n, %)	23 (11.7%)		
	5 (n, %)	16 (8.1%)		
Are you familiar with the principles of ALARA (As Low As Reasonably Achievable) when setting exposure parameters review and adjust exposure parameters based on patient characteristics and examination requirements	Yes (n, %)	175 (88.8%)	χ2 (1, 197) = 118.83	< 0.001
	No (n, %)	22 (11.2%)		
Can you describe the relationship between exposure parameters and image quality in CT scans	Yes (n, %)	173 (87.8%)	χ2 (1, 197) = 112.70	< 0.001
	No (n, %)	24 (12.2%)		

Table 5. **Level (Score) of competency among different parameters**
Tab. 5. **Úroveň (skóre) kompetence mezi různými parametry**

Parameters		Knowledge about dose parameters, median (IQR)	Knowledge about quality parameters, median (IQR)	Knowledge about balance parameters, median (IQR)	Total knowledge, median (IQR)
Total		5.00 (4.00–6.00)	9.00 (7.00–11.00)	3.00 (3.00–3.00)	15.00 (14.00–19.00)
Level of radiology education[a]					
	Diploma	4.00 (3.00–5.00)	8.00 (7.00–9.00)	3.00 (3.00–3.00)	15.00 (14.00–17.00)
	Bachelor	5.00 (3.00–6.00)	9.00 (6.00–11.00)	3.00 (2.00–3.00)	15.50 (13.00–20.00)
	Master	5.00 (4.00–6.00)	11.00 (7.00–12.00)	3.00 (3.00–3.00)	19.00 (14.00–21.00)
	p-value	0.055	0.010	0.823	0.017
Job title[b]					
	Technologists	5.00 (4.00–6.00)	9.00 (7.00–12.00)	3.00 (2.25–3.00)	17.00 (14.00–20.00)
	Radiographers	4.00 (3.00–5.00)	8.00 (6.00-11.00)	3.00 (2.50–3.00)	15.00 (12.00–17.50)
	p-value	0.001	0.046	0.858	0.013
Total years of experience[a]					
	Less than 5 years	4.00 (3.00–5.00)	8.00 (6.00–9.00)	3.00 (2.00–3.00)	14.00 (12.00–16.00)
	6–10 years	4.00 (3.00–6.00)	9.00 (7.000–11.25)	3.00 (2.00–3.00)	15.00 (14.00–19.00)
	11–15 years	5.00 (4.00–6.00)	11.00 (7.00–12.00)	3.00 (3.00–3.00)	19.00 (13.25–20.75)
	16–20 years	6.00 (4.00–6.00)	11.00 (8.00–12.00)	3.00 (3.00–3.00)	20.00 (13.00–21.00)
	21–25 years	4.00 (2.00–)	10.00 (10.00–)	3.00 (3.00–3.00)	17.00 (15.00–)
	> 25 years	4.00 (3.00–5.00)	10.00 (10.00–11.00)	2.00 (2.00–3.00)	16.00 (16.00–18.00)
	p-value	0.041	0.000	0.007	0.001
Work location[a]					
	Governmental hospitals	4.00 (3.00–5.00)	8.00 (6.00–11.00)	3.00 (3.00–3.00)	15.00 (11.75–20.00)
	Private hospitals & centers	5.00 (4.00–6.00)	9.00 (7.00–11.50)	3.00 (3.00–3.00)	16.00 (14.00–20.00)
	Military hospitals	4.00 (2.75–5.00)	8.00 (6.00–10.00)	3.00 (2.00–3.00)	15.00 (12.00–17.00)
	p-value	0.038	0.132	0.509	0.051
Gender[b]					
	Male	4.00 (3.75–6.00)	8.00 (7.00–11.00)	3.00 (2.00–3.00)	15.00 (12.75–20.00)
	Female	5.00 (3.00–5.00)	9.00 (7.00–11.00)	3.00 (3.00–3.00)	16.00 (14.00–19.00)
	p-value	0.901	0.367	0.764	0.533
Age[a]					
	Less than 21 years	3.00 (2.00–5.00)	9.00 (7.00–10.00)	3.00 (2.00–3.00)	15.00 (13.00–16.00)
	21–30 years	4.00 (4.00–5.00)	8.00 (7.00–10.00)	3.00 (2.00–3.00)	15.00 (14.00–16.00)
	31–40 years	4.00 (3.00–6.00)	9.00 (6.00–12.00)	3.00 (3.00–3.00)	16.00 (11.00–20.50)
	41–50 years	5.00 (4.00–6.00)	11.00 (8.00–12.00)	3.00 (3.00–3.00)	19.00 (15.00–21.00)
	51–60 years	4.00 (4.00–5.00)	10.00 (8.50–11.00)	2.00 (2.00–2.50)	16.00 (15.50–17.50)
	More than 61 years	3.50 (3.00–)	9.00 (7.00–)	2.00 (1.00–)	14.50 (13.00–)
	p-value	0.077	0.034	0.003	0.014
Attend specialized CT training course/s after graduation[b]					
	Yes	5.00 (4.00–6.00)	9.00 (7.00–11.25)	3.00 (3.00–3.00)	16.00 (14.00–20.00)
	No	4.00 (3.00–5.00)	8.00 (6.00–10.00)	2.00 (2.00–3.00)	14.00 (12.00–17.00)
	p-value	0.024	0.044	0.000	0.005

[a]Kruskal-Wallis test, [b]Mann-Whitney U test

where the difference reached a high level of statistical significance ($p < 0.001$). Participants with 11–20 years of experience exhibited the highest levels of knowledge across these domains.

Participants employed in private hospitals or centers demonstrated significantly higher knowledge of patient dose compared to those working in military and governmental hospitals ($p = 0.038$). However, the differences in knowledge regarding image quality, balance, and total knowledge were not statistically significant Table 5.

Age group analysis showed that participants aged 41–50 years had the highest knowledge scores. Although a slight decline was observed in participants over 50 years of age, their knowledge remained superior compared to those aged 21–40 years.

Importantly, participants who had attended specialized training courses post-graduation demonstrated significantly higher levels of knowledge concerning patient dose, image quality, dose balancing, and overall knowledge compared to those who had not pursued such training.

Comprehensive results are provided in Table 5.

Comparison Between Self-Assessment and Objective Knowledge

While the majority of participants reported high confidence in understanding CT parameters (88.8%) and familiarity with the relationship between exposure and image quality (87.8%), the median total knowledge score based on objectively scored sections (IV, V, and VII) was 15.00 (IQR: 14.00–19.00) out of a maximum of 23. Notably, although only 14.7% of participants rated their ability to balance dose and image quality as “excellent”, the median score for this domain was 3.00 (IQR: 3.00–3.00), the maximum possible. These results suggest that some participants may underestimate or overestimate their actual level of knowledge, especially in relation to dose balancing (Table 5).

DISCUSSION

The majority of participants in this study demonstrated a high level of awareness regarding the need to review and adjust exposure parameters based on patient characteristics, consistent with findings from Jordan (14), Norway (15), and Saudi Arabia (16), where most respondents reported confidence in parameter adjustment for optimized image quality and patient safety. Conversely, studies in Iran (17) and by Al Mohammad et al. (18) have reported lower overall knowledge scores, with some respondents indicating limited involvement in protocol optimization. Such differences may reflect variations in national training requirements, institutional role delineations, and access to structured continuing education. On the other hand, Kazemi et al, in 2023, in a study conducted in Iran, limited by a small sample size found that the total knowledge scores of CT technologists and radiographers on various scan parameters affecting image quality and dose were insufficient. It’s worth mentioning that most of the participants were technologists who claimed that scanning protocols were designed by radiologists only (17).

Participants of different age groups in the current study exhibited significant differences in knowledge related to image quality, balance, and total knowledge. This is in agreement with a study conducted to investigate the knowledge of DRLs, image quality, radiation dose and protocol parameters among Jordanian medical imaging professionals involved in CT scan procedures, where they observed that there was a significant difference in knowledge of the dose/protocol parameters and the DRL among different age groups (19).

In order to stay current with the newest technology developments and keep updated with the most optimal dosage regimen, radiographers must constantly refresh their skill set. Which eventually will have its implications on enhancing patient outcomes and reducing radiation-related dangers (20). Consequently, the present study illustrated that with different levels of education, there were statistically significant differences in image quality and total knowledge. This is nearly similar to a study conducted among Sri Lankan radiographers from 32 CT units and found that the level of education significantly impacted the knowledge about radiation protection, exposure parameters, and noise (21). Furthermore, a local study conducted in Jordan assessed the knowledge of CT radiographers about how CT exposure parameters affect patient dose and image quality demonstrated that radiographers have an overall good understanding of CT parameters and the academic educational level has a significant influence on participants’ knowledge. Where the participants with a master’s degree had a higher score compared to diploma ($p < 0.05$) (18). Additionally, in our study, the knowledge of patient dose, image quality and total knowledge was statistically significant different among participants’ years of experience groups. This is in accordance with Alhorani et al. in Jordan who noticed that there was a significant difference in knowledge of dose/protocol parameters according to years of experience (19).

A statistically significant difference was observed in the knowledge of patient dose, image quality, dose balance, and total knowledge between participants who reported attending specialized training courses after graduation and those who did not. However, this is not in alignment with a study conducted by Al Mohammad et al. who investigated the effects of additional training and years of experience on the knowledge score and found that there were no statistically significant difference between radiographers received additional training and the ones that did not (18).

These findings have direct implications for practice and policy. CT departments could integrate structured competency assessments into routine quality assurance programs, ensuring both self-perceived and tested knowledge are evaluated regularly. Training programs should emphasize hands-on protocol optimization workshops, especially targeting dose–image quality balancing. National regulatory bodies might consider mandating periodic continuing education credits in CT dose optimization as part of licensing renewal, aligning with international best practice standards. In Jordan, formal post-graduate certification in CT exposure optimization or radiation protection is not currently mandated at the national level. While many institutions encourage continuing education through workshops or vendor-led courses, there is no unified or accredited pathway equivalent to the structured curricula defined by European frameworks. In contrast, European recommendations -such as the European Commission Radiation Protection Report 175 and the European Federation of Radiographers Society (EFRS) guidance at EQF Level 6-emphasize structured, competency-based training in radiation protection and CT dose optimization. Our findings highlight the need for establishing national-level training frameworks aligned with such international standards.

In our study, although participants who were working in private hospitals showed a greater level of knowledge regarding image quality, balance, and total knowledge, this was not statistically significant in comparison to the public and military sectors. Additionally, our study showed that there is no statistically significant difference between male and female participants in terms of their knowledge of patient dose, image quality, dose balance, and total knowledge which all are partially comparable to Aldahery study who targeted radiographers working at local hospitals in KSA and found none of the demographics (e.g., gender, education level, and working departments) were significantly associated with the radiographers’ knowledge about radiation dose and DRLs (16).

Interestingly, our results revealed that CT technicians achieved slightly higher median scores than radiographers in several knowledge domains, including image quality and total knowledge. This difference may be attributed to technicians’ closer day-to-day engagement with CT scanner operation and protocol adjustment, especially in private sector settings. Alternatively, institutional role delineations or differences in clinical exposure may explain this variance. These findings suggest a need to harmonize core training content and continuing education opportunities across professional titles.

This study has several limitations. First, the use of a convenience sampling method may affect the generalizability of the findings, as participants who are more engaged or interested in CT practices may have been more likely to respond. Although we recruited from governmental, military, and private sectors, the sample may not fully reflect the distribution or characteristics of the entire CT workforce in Jordan due to the absence of a national registry. Second, the reliance on self-reported data, particularly in the perception-based sections, may be subject to social desirability bias. Third, the cross-sectional design limits the ability to assess causal relationships between educational/professional factors and knowledge levels.

CONCLUSION

Based on objectively assessed scores, radiographers and CT technologists in Jordan demonstrated a good overall understanding of CT exposure parameters, including patient dose, image quality, and their balance. However, only 14.7% rated their own knowledge of dose-image quality balancing as “excellent”, despite achieving the maximum possible score in the objective test for this domain. This discrepancy between confidence and tested competence highlights the importance of targeted educational interventions to bridge perception-performance gaps. Higher education levels, more years of experience, and attendance at specialized training were associated with better performance. While many participants reported confidence in their knowledge, the comparison between perceived and actual scores highlights the importance of structured assessment. Continued professional development and regular training remain essential to support safe and optimized imaging practice. ●

REFERENCES

1. **Assili S.** A Review of Tomographic ReconstructionTechniques for Computed Tomography. arxiv logo. Medical Physics 2018. Available from: https://doi.org/https://doi.org/10.48550/arXiv.1808.09172
2. **Oglat AA.** Assessment of Diagnostic Imaging Sector in Public Hospitals in Northern Jordan. Healthcare 2022; 10(6): 1136.
3. **Chamberlin JH, Baruah D, Smith C, et al.** Cardiac Computed Tomography Protocols in Structural Heart Disease: A State-of-the-Art Review. Seminars in Roentgenology 2024; 59(1): 7–19. Available from: https://doi.org/https://doi.org/10.1053/j.ro.2023.12.001
4. **Irsal M, Mukhtar AN, Winarno G, et al.** The Effect of Kilovoltage and Milliampere-Second Parameters on CT Number: Study Phantom Quality Control CT Scan. SANITAS J. Teknol. dan Seni Kesehat 2022; 13(2): 237–244.
5. **Abdulkareem NK, Hajee SI, Hassan FF, et al.** Investigating the slice thickness effect on noise and diagnostic content of single-source multi-slice computerized axial tomography. J Med Life 2023; 16(6): 862–867. Available from: https://doi.org/10.25122/jml-2022-0188
6. **Mahmoudi F, Naserpour M, Farzanegan Z, et al.** Evaluation of radiographers’ and CT technologists’ knowledge regarding CT exposure parameters. Polish Journal of Medical Physics and Engineering 2019; 25(1): 43–50. Available from: https://doi.org/10.2478/pjmpe-2019-0007
7. **Sodhi KS, Krishna S, Saxena AK, et al.** Clinical application of ’Justification’ and ’Optimization’ principle of ALARA in pediatric CT imaging: How many children can be protected from unnecessary radiation? European Journal of Radiology 2015; 84(9): 1752–1757. Available from: https://doi.org/https://doi.org/10.1016/j.ejrad.2015.05.030
8. **Berrington de Gonzalez A, Pasqual E, Veiga L.** Epidemiological studies of CT scans and cancer risk: the state of the science. British Journal of Radiology 2021; 94(1126). Available from: https://doi.org/10.1259/bjr.20210471
9. **Mallinson MA, Hardy M, Scally AJ.** Developing CT workforce competencies: What knowledge and skills should we expect of an early career radiographer? Radiography 2024; 30(5): 1355–1362. Available from: https://doi.org/https://doi.org/10.1016/j.radi.2024.07.010
10. **Raman SP, Mahesh M, Blasko RV, et al.** CT Scan Parameters and Radiation Dose: Practical Advice for Radiologists. Journal of the American College of Radiology 2013; 10(11): 840–846. Available from: https://doi.org/https://doi.org/10.1016/j.jacr.2013.05.032
11. **Hawarihewa PM, Satharasinghe D, Amalaraj T, et al.** An assessment of Sri Lankan radiographer’s knowledge and awareness of radiation protection and imaging parameters related to patient dose and image quality in computed tomography (CT). Radiography 2022; 28(2): 378–386. Available from: https://doi.org/https://doi.org/10.1016/j.radi.2021.10.010
12. **Al Mohammad B, Alakhras MM, Reed W.** Assessing the knowledge of CT radiographers regarding how CT parameters affect patient dose and image quality. European Journal of Radiology 2023; 166: 111023.
13. **Alzyoud K, Al-Murshedi S, England A.** Diagnostic Reference Levels of Radiographic and CT Examinations in Jordan: A Systematic Review. Health Physics. 2024; 126(3): 156–162. Available from: https://doi.org/10.1097/hp.0000000000001778
14. **Rawashdeh M, McEntee MF, Zaitoun M, et al.** Knowledge and practice of computed tomography exposure parameters amongst radiographers in Jordan. Comput Biol Med. 2018; 102: 132–137. Available from: https://doi.org/10.1016/j.compbiomed.2018.09.020
15. **Kada S.** Knowledge of CT exposure parameters among Norwegian student radiographers. BMC Medical Education 2020; 20(1): 302. Available from: https://doi.org/10.1186/s12909-020-02233-y
16. **Aldahery ST.** Assessment of radiographers’ knowledge about radiation doses and DRLs in computed tomography departments in Jeddah, Saudi Arabia: A cross-sectional study. Saudi Pharm J. 2023; 31(11): 101820. Available from: https://doi.org/10.1016/j.jsps.2023.101820
17. **Kazemi Z, Hajimiri K, Saghatchi F, et al.** Assessment of the knowledge level of radiographers and CT technologists regarding computed tomography parameters in Iran. Radiation Medicine and Protection 2023; 4(1): 60–64. Available from: https://doi.org/https://doi.org/10.1016/j.radmp.2023.01.002
18. **Al Mohammad B, Alakhras MM, Reed W.** Assessing the knowledge of CT radiographers regarding how CT parameters affect patient dose and image quality. Eur J Radiol. 2023; 166: 111023. Available from: https://doi.org/10.1016/j.ejrad.2023.111023
19. **Alhorani Q, Al-Ibraheem A, Rawashdeh M, et al.** Investigating knowledge of DRLs, image quality and radiation dose in PET/CT and CT imaging among medical imaging professionals. Heliyon 2024; 10(9): e30030. Available from: https://doi.org/10.1016/j.heliyon.2024.e30030
20. **Rehani MM, Brady Z.** Contemporary issues in radiation protection in medical imaging: introductory editorial. Br J Radiol. 2021; 94(1126): bjr20219004. Available from: https://doi.org/10.1259/bjr.20219004
21. **Hawarihewa PM, Satharasinghe D, Amalaraj T, et al.** An assessment of Sri Lankan radiographer’s knowledge and awareness of radiation protection and imaging parameters related to patient dose and image quality in computed tomography (CT). Radiography (London) 2022; 28(2): 378–386. Available from: https://doi.org/10.1016/j.radi.2021.10.010

ATTACHMENT 1

Section I Demographic information (10 items)

1. Workplace:

a. governmental b. Private hospitals & centers c. Military

2. Gender:

a. Male b. Female

3. Level of radiology education:

a. Diploma b. Bachelor c. Master d. PhD

4. Job title:

a. Radiographers b. CT Technician

5. Age group:

a. < 21 b. > 21 – ≤ 30 c. > 30 – ≤ 40 d. > 40 – ≤ 50 e. > 50 – ≤ 60 f. > 60

6. Total Years of experience:

a. ≤ 5 ys b. > 5 – ≤ 10 ys c. > 10 – ≤ 15 ys d. > 15 – ≤ 20 ys e. > 22 – ≤ 25 ys f. > 25

7. Did you attend any specialized CT training course after graduation?

a. Yes b. No

8. Are you keep updated to the new training courses about CT exposure and dose optimization?

a. Yes b. No

9. Who is responsible to decide the routine CT scan protocols at your department?

a. Radiographers (MD) b. CT technicians c. Application specialist d. Medical physicist

10. When was the last time you changed any CT protocol?

a. One month – ≤ 1 years b. > 1 – ≤ 2 years c. ≥ 2 years

Sections II Perception of academic degrees, certificates, and training programs impact on knowledge of different exposure parameters (5 items)

11. Do you believe that academic degree significantly influences your understanding of CT exposure parameters?

a. Yes b. No

12. How important do you think academic qualifications are in determining proficiency in adjusting exposure parameters for CT scans?

a. Strongly Agree b. Agree c. Neutral d. Disagree e. Strongly Disagree

13. Have you observed any differences in the knowledge and skills related to exposure parameters between colleagues with different academic degrees?

a. Yes b. No

14. Do you think that practical experience has a greater impact on your ability to optimize exposure parameters than academic qualifications?

a. Yes b. No

15. In your opinion, should there be additional certificate or training requirements related to exposure parameters for radiographers and CT technicians beyond academic qualifications?

a. Yes b. No

Section III Self-assessment of knowledge on patient dose (2 items)

16. Do you feel confident in your understanding of CT exposure parameters, such as mA, kVp, and scan time?

a. Yes b. No

17. Do you review and adjust exposure parameters based on patient characteristics and examination requirements?

a. Yes b. No

Section IV Objective knowledge of patient dose (7 items)

18. If we increase the KVp, the patient dose will?

a. Increase b. No effect c. Decrease

19. If we increase the KVp, the CT dose Index (CTDI) will?

a. Increase b. No effect c. Decrease

20. If we increase the mAs, the patient dose will?

a. Increase b. No effect c. Decrease

21. If we increase the pitch factor, the patient dose will?

a. Increase b. No effect c. Decrease

22. If we increase gantry rotation (speed), the patient dose will?

a. Increase b. No effect c. Decrease

23. If we use large slice thickness, the patient dose will?

a. Increase b. No effect c. Decrease

24. Does the Automatic tube current modulation (ATCM) decrease the patient dose?

a. Yes b. No

Section V Objective knowledge of image quality and noise (13 items)

25. If we increase the KVp, the image contrast will?

a. Increase b. No effect c. Decrease

26. If we increase the KVp, the image noise will?

a. Increase b. No effect c. Decrease

27. If we increase the mAs, the image noise will?

a. Increase b. No effect c. Decrease

28. If we increase the pitch factor, the z resolution will?

a. Increase b. No effect c. Decrease

29. If we increase the pitch factor, the spiral artifact will?

a. Increase b. No effect c. Decrease

30. If we increase the gantry rotation (speed), the image noise will?

a. Increase b. No effect c. Decrease

31. If we use large slice thickness, the z resolution will?

a. Increase b. No effect c. Decrease

32. If we use large slice thickness, the partial volume artifact will?

a. Increase b. No effect c. Decrease

33. The use of large window width will lead to a decrease in image contrast with no effect on patient dose.

a. True b. False

34. The use of automatic tube current modulation will lower the patient dose (average dose) in a specific region, such as pelvic CT scan while maintain image quality at an acceptable level.

a. True b. False

35. The use of ATCM is very efficient in case of metal artifacts.

a. True b. False

36. ATCM is affected by improper patient positioning.

a. True b. False

37. Smooth reconstruction kernel, increases the visualization of noise.

a. True b. False

Section VI Self-assessment of knowledge on dose–image quality balance (3 items)

38. How you rate your confidence to change the CT protocol parameter correctly, by taking in your account the patient dose and image quality? (1 excellent, 5 poor)

a. Excellent b. Good c. Fair d. Week e. Poor

39. Are you familiar with the principles of ALARA (As Low As Reasonably Achievable) when setting exposure parameters?

a. Yes b. No

40. Can you describe the relation between exposure parameters and image quality in CT scans?

a. Yes b. No

Section VII Objective knowledge of balancing dose and image quality (3 items)

41. ATCM increases the dose to obese patients.

a. True b. False

42. Large size patient require high mAs settings.

a. True b. False

43. Pediatrics patient requires low exposure settings.

a. True b. False